SAFETY RE-EVALUATIONS OF THE BER II

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ABSTRACT

After the Chernobyl accident, the German government demanded to do every ten years safety reevaluations of nuclear power plants. Although the BER II is only a small research reactor, we are also obliged to prepare a safety revision for our reactor. Because this was not done for a research reactor yet, the requirements and methods were quite unclear.

Therefore, our first step was to establish a structure of a safety analysis and to describe the planned work for each item. This proposal was then submitted to our authorities and approved by them. After that we started the safety reevaluation according to this proposal. The work will be finished in 2003. Thus, in this paper, the work, which has been done and the results, which we have gained so far, will be presented.

Introduction

The BER II (**B**erliner **E**xperimental **R**eactor) of the Hahn-Meitner-Institut (HMI) in Berlin is a swimming pool type reactor, in operation since December, 1973. The main field of research is neutron scattering.

The reactor was upgraded from August 1985 until April 1991, in order to increase the neutron flux at the beam tubes. Hereby, many alterations took place: a power increase from 5 to 10 MW, a decrease in the core size and an encompassing of a Be-reflector, and finally the installation of a Cold Neutron Source.

In order to get a license for these improvements, we were obliged to replace nearly all equipment of the old reactor system and had to purchase up-to-date systems. This meant, that not only the whole electronic safety system was renewed, but also the power supply system, the ventilation system and the cooling system. Furthermore, several steps had to be performed to improve the fire protection system. Last but not least , we had to deliver written records of all tasks performed during reactor operation and give a complete safety analysis every 10 years.

Periodically, safety evaluations of nuclear power plants were introduced by the German government as a result of the Chernobyl accident. Although, originally intended only for nuclear power plants, a 10-year safety evaluation for our research reactor BER II was also requested by the authorities, before granting the license for restarting the reactor in 1991.

Since there is no precedent of a safety re-evaluation for German research reactors, our first step was to deliver a proposal about the methods and the scope of the planned safety study. This proposal is approved and now the final safety evaluation will be completed.

Procedure of Safety Re-evaluation

There are three main topics, which shall be considered in the safety review. These are:

- Check and update of the documentation,
- Evaluate experience during reactor operation and prepare proposals for changes if necessary,
- Update the safety analysis and calculations for consequences and environmental impacts in case of accidents.

The safety re-evaluation has to be done not only for the reactor itself, but also for safeguard inspections and in-core irradiation devices. An incident with the latter has already shown, that the existing safety analysis values for the irradiation device were not sufficient and therefore additional examinations had to be carried out. This incident, which might occur in other research reactors as well, is described below.

Documentation

The first step in the safety re-evaluation is to revise and update all the papers, describing the reactor and operation procedures. These are: a reactor description, an operating manual and the detailed documents, i. e. drawings, certifications etc., of all reactor parts. While the reactor description has to be updated only every 10 years, the other documentation has to be updated immediately after any modification in systems or components occurs.

The reactor description gives an overview of the reactor and is the basis for the analysis of possible operating problems or accident stipulations. Therefore, a first step will be to update the reactor description, which was last reviewed in 1994.

In the operating manual all requirements and information in order to run the reactor are documented. Aside from instructions for handling the reactor systems, this manual includes detailed instructions for any case of possible operating problems or an accident. Furthermore, it contains all requirements of permit and a detailed description of the reactor group organization. Changes in this manual have to be approved by the regulators and therefore are often time consuming.

This manual will be scrutinized carefully and compared to the existing procedures of reactor operation. If discrepancies are detected, they have to be eliminated either by adapting the text in the manual or by better training of the reactor staff.

Finally, all the detailed documents will be thoroughly checked and also be checked if all changes in the reactor are included.

Experience with the reactor operation of the BER II

The upgraded reactor BER II is now in operation for 10 years and several high quantity of data in respect to the reactor performance, regular checks etc. are available. For a safety assessment it is essential to review all this data and examine all unplanned reactor shut-downs and failures of reactor components. Thereby, our goal is to detect:

- Long term trends in values of key indicators which might lead to serious problems,
- Failures in reactor components,
- Insufficient operation and maintenance of the reactor.

Additionally, experience with the following items will be summarized and then examined, whether the procedures worked out well or some improvements have to be made.

- Quality assurances procedures,
- Training of reactor staff,
- Organization of reactor operating group,
- Maintenance, tests and inspection program.

Update safety analysis

The main feature point in a safety analysis is to properly identify all possible accidents and the limiting or bounding sequences. This was written down in the safety report, which we submitted to the authorities 18 years ago, when applying for a license for upgrading the reactor. Since then a lot of experience have been gathered, which will be taken into account, when re-examining the accident sequences and whether some sequences, resulting from practice, might be re-evaluated.

The consequences of such events have then to be estimated. If the environmental impact is worse than the assumed limiting sequence in the original safety report, modifications of the reactor or of the operating procedures have then to be made to preclude such accidents.

Furthermore, the computer models and programs, used in the original safety report, are thoroughly checked, whether there are new developments or knowledge, which could change the computed results. Because the earlier models or programs include conservative methods, it is expected that new calculations will result in higher safety margins.

Burst of samples in in-core irradiation device

In February 2002, there was an automatic scram of our reactor caused by a sudden increase in reactor power. The course of events, which led to this power increase, can be explained as follows:

The in-core irradiation device acts as a water gap in the middle of the core, which is much larger than needed for neutron moderation; therefore, the reactor is locally over-moderated. Thus, whenever water is replaced by samples, there is an increase of reactivity, which has to be compensated by the control rods. In the safety analysis for this irradiation device it was assumed that all samples are dropped at once into the irradiation position, resulting in a sudden power increase. This can be controlled by the safety system as long as the brought in reactivity is less than 0,29%. Therefore, only samples with a lesser reactivity effect were allowed. A reactivity increase as the consequence of samples bursting, however, was not considered, although this may result in higher values than 0,29%. In February there was only one sample within the core, and the reactivity increase was clearly below 0,29%. However, in the

safety analysis we have to take into account that there could be 9 samples within the irradiation device, which all burst at once. So, one main point of the safety re-evaluation was to prove that even in such a case the reactor will remain under control, which was not possible. Therefore, a new irradiation device was proposed, in order to limit the displacement of water in case of bursting samples.

Results

The safety re-evaluation is not yet finished, but, some points are already improved:

- Training of our staff: We used to give one day lessons every month. Now, we will train our staff by two more additional weeks per year.
- We used to warm up the cold source too quickly, at least 6 times per year, in order to do maintenance and checks. After warming up, stress was noticed in flanges, which often led to leaks in the sealing of the samples, therefore, we changed our maintenance routine. The Cold Source remains cold for approximately a half year and is only slowly warmed up twice a year.
- After changes in reactor components, the mechanics were often reluctant to do the required paper work, which sometimes led to confusion. This is now done more systematically.
- The in-core irradiation device will be replaced in order to limit the possible water displacement, in case of bursting samples.

These examples show, that after more than 10 years of routine reactor operation, it is worthwhile to check carefully, whether the required safety standard is still met or should be improved.